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Summer 2014 Pathways Report

Mission Assurance Engineering
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Introduction

Over the summer I had the exciting opportunity to work for NASA at the Kennedy Space Center as a Mission Assurance Engineering intern. When I was offered a position in mission assurance for the Safety and Mission Assurance directorate's Launch Services Division, I didn't really know what I would be doing, but I knew it would be an excellent opportunity to learn and grow professionally. In this report I will provide some background information on the Launch Services Division, as well as detail my duties and accomplishments during my time as an intern. Additionally, I will relate the significance of my work experience to my current academic work and future career goals.

Mission Assurance Engineering

Mission assurance engineering deals primarily with risk. More specifically, it involves the identification of potential issues, an assessment of the likelihood that these issues will impact a given system, an evaluation of the potential impact, and finally, the development of strategies to mitigate potentially hazardous issues. At the Launch Services Division, these practices are applied to the launch vehicles that carry payloads into earth orbit and beyond. The importance of effective mission assurance quickly becomes apparent given the technical complexity of launch vehicles coupled with the significant cost of launching a payload into space. While risks can never be completely eliminated, they need to be quantified and understood so that informed decisions can be made.

The Mission Assurance branch is composed of a diverse group of engineers with expertise in a variety of fields. This is essential to the work being done, as a launch vehicle is itself composed of a diverse collection of systems and subsystems. From propulsion, to avionics, to pyrotechnics, the Mission Assurance branch has to have the knowledge to effectively evaluate a system and identify areas of potential concern. Typically an engineer is assigned to investigate systems within their realm of expertise, but as an intern I was able to gain exposure to the full spectrum of systems which comprise a launch vehicle. While normally this would be a herculean task to accomplish over a summer internship, being surrounded by experts who could answer any question I could formulate made it one of the most engaging learning experiences I have had.

Duties

After gaining a general familiarization with launch vehicles, I was tasked with learning more about the Delta II rocket, with a focus on its guidance, navigation, and control systems. The Delta II (shown below in Figure 1) was chosen for me to study because the next mission the Launch Services Division was providing support for was the Orbital Carbon Dioxide Observatory 2(OCO-2), which was being launched on a Delta II. In preparation for the upcoming launch, I reviewed telemetry from previous Delta II missions. This allowed me to learn the tools used to analyze telemetry as well as become familiar with what to expect during the OCO-2 launch. On launch day I reviewed and analyzed the live telemetry feed of the launch vehicle looking for anomalous readings that could be indications of potential problems. Reviewing telemetry from a launch vehicle is a vital tool for assessing an onboard systems' performance. In fact, in many cases it is the only way to do so once a rocket has taken off.



Figure 1: A Delta II Launch Vehicle (Image credit: NASA)

In addition to these duties, I was tasked with developing a presentation exploring the potential dangers of the space radiation environment, specifically trapped energetic protons, on launch vehicles, and to investigate potential mitigation strategies. While the specific details are beyond the scope of this report, the main threat to launch vehicles from this type of radiation comes in the form of Single Event Effects (SEE) which can cause the electronics onboard the vehicle to behave in a non-ideal manor. If a critical system is damaged by these effects, such as the flight computer, the launch vehicle can fail, and as a result, the mission can fail. Preparing this presentation was a great learning opportunity, as it exposed me to several new ideas. The first was a reminder that what is taught in school can vary dramatically with what is encountered in real world conditions. In this case I was surprised at just how damaging

ionizing radiation can be to electronics. Typically when studying electronics in electrical engineering, ideal models are used and environmental variables are assumed to be negligible. During my investigation it was truly eye opening to see how far from the ideal a harsh environment can cause a circuit to operate. This was an important lesson to learn as models are used extensively in engineering, and it is vital to know their limitations. Basing an analysis on data obtained from an incorrectly applied model is a real problem that can have disastrous consequences.

Additionally this project exposed me to the idea that many risks cannot be eliminated; only mitigated. Any strategy I investigated for completely eliminating the risk of proton radiation would either be too costly or otherwise unfeasible to fully implement. It was, however, possible to reduce the risk of a mission failure by increasing the cost or reducing mission capability. This reinforces the idea that the most important aspect of risk analysis is understanding the risk. Once that is accomplished informed decisions can be made as to the acceptability of the risk for a given mission.

Significance of Work Experience

My work experience at NASA over the summer has been extremely beneficial and will no doubt help me in both my continuing education as well as my future career. One aspect of my intern experience which I found to be particularly valuable was working as part of a diverse, multidisciplinary, highly motivated team. This type of environment is so conducive to learning and both personal and professional growth that its benefits cannot be overstated. Every day I came to work I learned something new. Even though some of what I learned is outside my field, being exposed to it has made me a better engineering student. It has taught me how to formulate more intelligent questions and has given me a much greater awareness of engineering principles. This will be particularly helpful for my senior design project, in which I will be integrating into a team composed of students from several different engineering disciplines.

Another valuable aspect of my intern experience was that it helped me improve my presentation skills. I attended many briefings and review boards which demonstrated the importance of clear and effective communication. While the engineers of the Mission Assurance branch work cohesively as a team, they also have to be able to work independently investigating issues within their areas of expertise. Their findings have to be clearly communicated along with their recommendations and rationale, all while being cognizant of the audience they are presenting to. By taking part in these briefings I learned two ways to improve my own presentations. The first is to “tell a story.” This means to convey information in a logical order that the audience can easily follow. Ensuring this type of coherent flow in a

presentation greatly improves its clarity. The second is to limit the amount of extraneous detail that is presented. While details are extremely important in engineering, too much detail can be detrimental to the clarity of a presentation, especially if the audience is composed of members with varying levels and areas of technical expertise. Instead, such details should be moved from the main body of the presentation to a reference section so they are available if questions arise. This allows the main message to be communicated clearly and concisely, while still having all the information available. Presentations are a part of school as well as engineering careers, so being able to more effectively communicate information will be a valuable asset moving forward.

Conclusion

My time working at the Kennedy Space Center as a Pathways intern has been an amazing opportunity. I've been told NASA is one of the best places to work, and I believe it. Being surrounded by intelligent, motivated people who are above all passionate about their work is an experience like none other. The knowledge I gained during my short 10 week summer rotation will serve me well in my academic pursuits and future career aspirations. I look forward to future rotations and possible permanent employment with NASA.